

Highlights

World marketed energy consumption increases by 49 percent from 2007 to 2035 in the Reference case. Total energy demand in the non-OECD countries increases by 84 percent, compared with an increase of 14 percent in the OECD countries.

In the *IEO2010* Reference case—which reflects a scenario assuming that current laws and policies remain unchanged throughout the projection period—world marketed energy consumption grows by 49 percent from 2007 to 2035. Total world energy use rises from 495 quadrillion British thermal units (Btu) in 2007 to 590 quadrillion Btu in 2020 and 739 quadrillion Btu in 2035 (Figure 1).

The global economic recession that began in 2007 and continued into 2009 has had a profound impact on world energy demand in the near term. Total world marketed energy consumption contracted by 1.2 percent in 2008 and by an estimated 2.2 percent in 2009, as manufacturing and consumer demand for goods and services declined. Although the recession appears to have ended, the pace of recovery has been uneven so far, with China and India leading and Japan and the European Union member countries lagging. In the Reference case, as the economic situation improves, most nations return to the economic growth paths that were anticipated before the recession began.

The most rapid growth in energy demand from 2007 to 2035 occurs in nations outside the Organization for Economic Cooperation and Development¹ (non-OECD nations). Total non-OECD energy consumption increases by 84 percent in the Reference case, compared with a 14-percent increase in energy use among the OECD countries. Strong long-term growth in gross domestic product (GDP) in the emerging economies of non-OECD countries drives the fast-paced growth in energy demand. In all the non-OECD regions combined, economic activity—as measured by GDP in purchasing power parity terms—increases by 4.4 percent per year on average, compared with an average of 2.0 percent per year for OECD countries.

The *IEO2010* Reference case projects increased world consumption of marketed energy from all fuel sources over the 2007-2035 projection period (Figure 2). Fossil fuels (liquid fuels and other petroleum,² natural gas, and coal) are expected to continue supplying much of the energy used worldwide. Although liquid fuels remain the largest source of energy, the liquids share of world

Figure 1. World marketed energy consumption, 2007-2035 (quadrillion Btu)

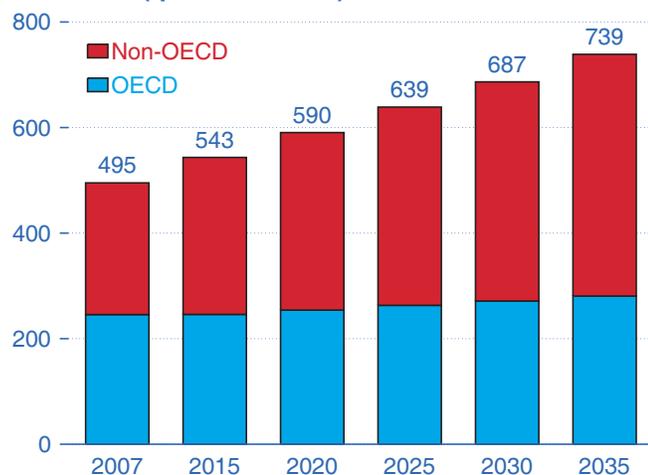
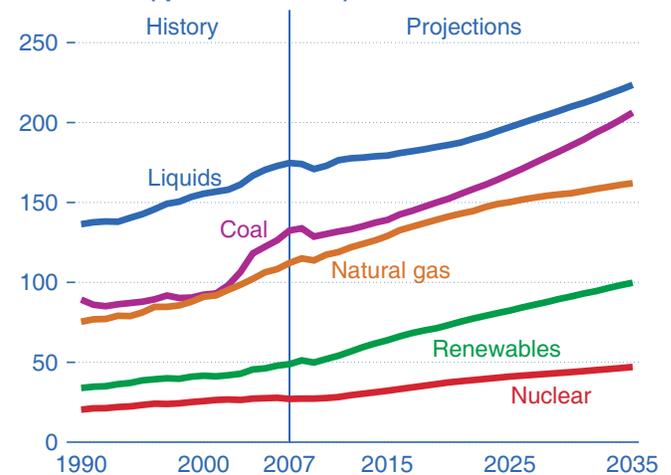


Figure 2. World marketed energy use by fuel type, 1990-2035 (quadrillion Btu)



¹Current OECD member countries (as of March 10, 2010) are the United States, Canada, Mexico, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, Japan, South Korea, Australia, and New Zealand. Chile became a member on May 7, 2010, but its membership is not reflected in *IEO2010*.

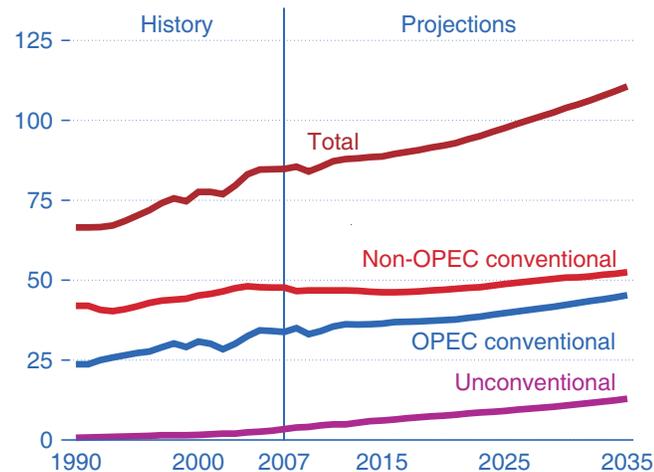
²Liquid fuels and other petroleum include petroleum-derived fuels and non-petroleum-derived liquid fuels, such as ethanol and biodiesel, coal-to-liquids, and gas-to-liquids. Petroleum coke, which is a solid, is included. Also included are natural gas liquids, crude oil consumed as a fuel, and liquid hydrogen.

marketed energy consumption falls from 35 percent in 2007 to 30 percent in 2035, as projected high world oil prices lead many energy users to switch away from liquid fuels when feasible. In the Reference case, the use of liquids grows modestly or declines in all end-use sectors except transportation, where in the absence of significant technological advances liquids continue to provide much of the energy consumed.

Average oil prices³ increased strongly from 2003 to mid-July 2008, when prices collapsed as a result of concerns about the deepening recession. In 2009, oil prices trended upward throughout the year, from about \$42 per barrel in January to \$74 per barrel in December. Oil prices have been especially sensitive to demand expectations, with producers, consumers, and traders continually looking for an indication of possible recovery in world economic growth and a likely corresponding increase in oil demand. On the supply side, OPEC's above-average compliance to agreed-upon production targets increased the group's spare capacity to roughly 5 million barrels per day in 2009. Further, many of the non-OPEC projects that were delayed during the price slump in the second half of 2008 have not yet been revived.

After 2 years of declining demand, world liquids consumption is expected to increase in 2010 and strengthen thereafter as the world economies recover fully from the effects of the recession. In the *IEO2010* Reference case, the price of light sweet crude oil in the United States (in real 2008 dollars) rises from \$79 per barrel in 2010 to \$108 per barrel in 2020 and \$133 per barrel in 2035.

Figure 3. World liquids production, 1990-2035 (million barrels per day)



³The oil price reported in *IEO2010* is for light sweet crude oil delivered to Cushing, Oklahoma. The price series is consistent with spot prices for light sweet crude oil reported on the New York Mercantile Exchange (NYMEX). All oil prices are in real 2008 dollars per barrel, unless otherwise noted.

⁴"Above-ground" constraints refer to those nongeological factors that might affect supply, including: government policies that limit access to resources; conflict; terrorist activity; lack of technological advances or access to technology; price constraints on the economical development of resources; labor shortages; materials shortages; weather; environmental protection actions; and other short- and long-term geopolitical considerations.

World energy markets by fuel type

Liquid fuels

Liquids remain the world's largest energy source throughout the *IEO2010* Reference case projection, given their importance in the transportation and industrial end-use sectors. World use of liquids and other petroleum grows from 86.1 million barrels per day in 2007 to 92.1 million barrels per day in 2020, 103.9 million barrels per day in 2030, and 110.6 million barrels per day in 2035. On a global basis, liquids consumption remains flat in the buildings sector, increases modestly in the industrial sector, but declines in the electric power sector as electricity generators react to rising world oil prices by switching to alternative fuels whenever possible. In the transportation sector, despite rising prices, use of liquid fuels increases by an average of 1.3 percent per year, or 45 percent overall from 2007 to 2035.

To meet the increase in world demand in the Reference case, liquids production (including both conventional and unconventional liquid supplies) increases by a total of 25.8 million barrels per day from 2007 to 2035. The Reference case assumes that OPEC countries will invest in incremental production capacity in order to maintain a share of approximately 40 percent of total world liquids production through 2035, consistent with their share over the past 15 years. Increasing volumes of conventional liquids (crude oil and lease condensate, natural gas plant liquids, and refinery gain) from OPEC producers contribute 11.5 million barrels per day to the total increase in world liquids production, and conventional supplies from non-OPEC countries add another 4.8 million barrels per day (Figure 3).

Unconventional resources (including oil sands, extra-heavy oil, biofuels, coal-to-liquids, gas-to-liquids, and shale oil) from both OPEC and non-OPEC sources grow on average by 4.9 percent per year over the projection period. Sustained high oil prices allow unconventional resources to become economically competitive, particularly when geopolitical or other "above ground" constraints⁴ limit access to prospective conventional resources. World production of unconventional liquid fuels, which totaled only 3.4 million barrels per day in 2007, increases to 12.9 million barrels per day and accounts for 12 percent of total world liquids supply in 2035. Oil sands from Canada and biofuels, largely from Brazil and the United States, are the largest components of future unconventional production in the *IEO2010* Reference case, providing a combined 70 percent of the

increment in total unconventional supply over the projection period.

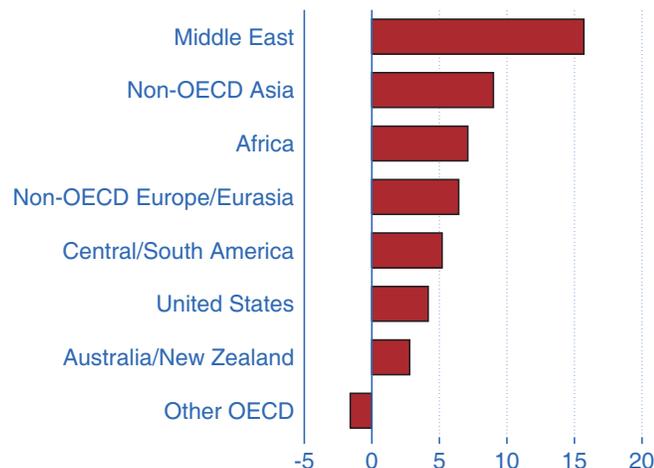
Natural gas

Natural gas consumption worldwide increases by 44 percent in the Reference case, from 108 trillion cubic feet in 2007 to 156 trillion cubic feet in 2035. In 2009, world natural gas consumption declined by an estimated 1.1 percent, and natural gas use in the industrial sector fell even more sharply, by 6.0 percent, as demand for manufactured goods declined during the recession. The industrial sector currently consumes more natural gas than any other end-use sector, and in the projection it continues as the largest user through 2035, when 39 percent of the world’s natural gas supply is consumed for industrial purposes. Electricity generation is another important use for natural gas throughout the projection, and its share of the world’s total natural gas consumption increases from 33 percent in 2007 to 36 percent in 2035.

To meet the projected growth in demand for natural gas, producers will need to increase annual production in 2035 to a level that is 46 percent higher than the 2007 total. In the near term, as world economies begin to recover from the downturn, global demand for natural gas is expected to rebound, with natural gas supplies from a variety of sources keeping markets well supplied and prices relatively low. The largest projected increase in natural gas production is for the non-OECD region (Figure 4), with the major increments coming from the Middle East (an increase of 16 trillion cubic feet from 2007 to 2035), Africa (7 trillion cubic feet), and Russia and the other countries of non-OECD Europe and Eurasia (6 trillion cubic feet).

Although the extent of the world’s tight gas, shale gas, and coalbed methane resource base has not yet been assessed fully, the *IEO2010* Reference case projects a

Figure 4. Net change in world natural gas production by region, 2007-2035 (trillion cubic feet)



substantial increase in those supplies—especially from the United States but also from Canada and China. In the United States, one of the keys to increasing natural gas production has been advances in horizontal drilling and hydraulic fracturing technologies, which have made it possible to exploit the country’s vast shale gas resources. Rising estimates of shale gas resources have helped to increase total U.S. natural gas reserves by almost 50 percent over the past decade, and shale gas rises to 26 percent of U.S. natural gas production in 2035 in the *IEO2010* Reference case. Tight gas, shale gas, and coalbed methane resources are even more important for the future of domestic natural gas supplies in Canada and China, where they account for 63 percent and 56 percent of total domestic production, respectively, in 2035 in the Reference case.

World natural gas trade, both by pipeline and by shipment in the form of liquefied natural gas (LNG), is poised to increase in the future. Most of the projected increase in LNG supply comes from the Middle East and Australia, where a number of new liquefaction projects are expected to become operational within the next decade. In the *IEO2010* Reference case, world liquefaction capacity increases 2.4-fold, from about 8 trillion cubic feet in 2007 to 19 trillion cubic feet in 2035. In addition, new pipelines currently under construction or planned will increase natural gas exports from Africa to European markets and from Eurasia to China.

Coal

In the absence of national policies and/or binding international agreements that would limit or reduce greenhouse gas emissions, world coal consumption is projected to increase from 132 quadrillion Btu in 2007 to 206 quadrillion Btu in 2035, at an average annual rate of 1.6 percent. Much of the projected increase in coal use occurs in non-OECD Asia, which accounts for 95 percent of the total net increase in world coal use from 2007 to 2035 (Figure 5). Increasing demand for energy to fuel electricity generation and industrial production in the region is expected to be met in large part by coal. For example, installed coal-fired generating capacity in China more than doubles in the Reference case from 2007 to 2035, and coal use in China’s industrial sector grows by 55 percent. The development of China’s electric power and industrial sectors will require not only large-scale infrastructure investments but also substantial investment in both coal mining and coal transportation infrastructure.

Electricity

World net electricity generation increases by 87 percent in the Reference case, from 18.8 trillion kilowatthours in 2007 to 25.0 trillion kilowatthours in 2020 and 35.2 trillion kilowatthours in 2035. Although the recession slowed the rate of growth in electricity demand in 2008

and 2009, its growth returns to pre-recession rates by 2015 in the Reference case. In general, in OECD countries, where electricity markets are well established and consumption patterns are mature, the growth of electricity demand is slower than in non-OECD countries, where a large amount of potential demand remains unmet. In the Reference case, total net generation in non-OECD countries increases by 3.3 percent per year on average, as compared with 1.1 percent per year in OECD nations.

The rapid increase in world energy prices from 2003 to 2008, combined with concerns about the environmental consequences of greenhouse gas emissions, has led to renewed interest in alternatives to fossil fuels—particularly, nuclear power and renewable resources. As a result, long-term prospects continue to improve for generation from both nuclear and renewable energy sources—supported by government incentives and by higher fossil fuel prices.

Figure 5. World coal consumption by region, 1990-2035 (quadrillion Btu)

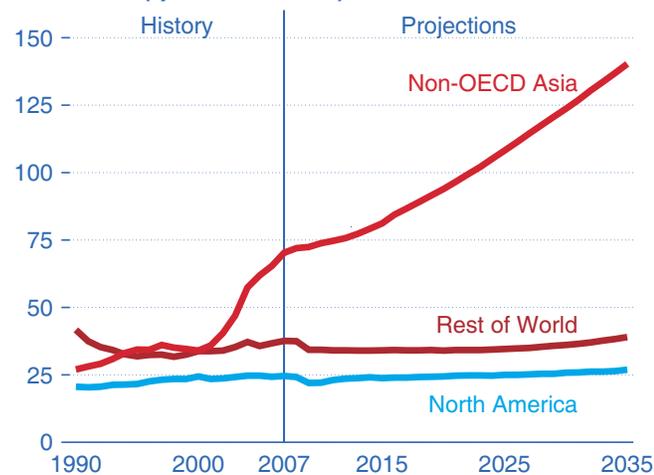
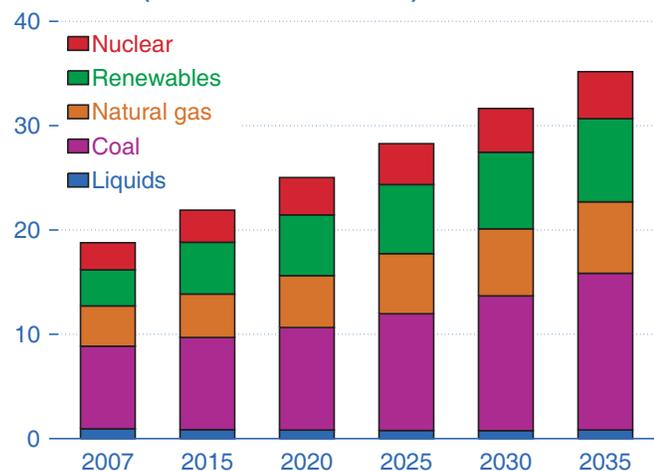


Figure 6. World net electricity generation by fuel, 2007-2035 (trillion kilowatthours)

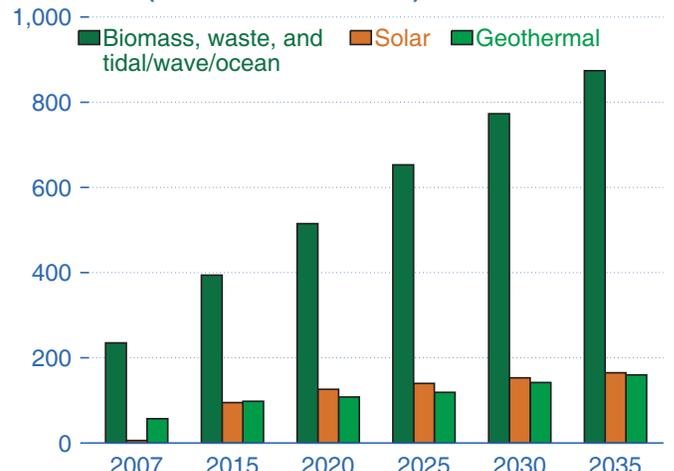


From 2007 to 2035, world renewable energy use for electricity generation grows by an average of 3.0 percent per year (Figure 6), and the renewable share of world electricity generation increases from 18 percent in 2007 to 23 percent in 2035. Coal-fired generation increases by an annual average of 2.3 percent in the Reference case, making coal the second fastest-growing source for electricity generation in the projection. The outlook for coal could be altered substantially, however, by any future legislation that would reduce or limit the growth of greenhouse gas emissions. Generation from natural gas and nuclear power—which produce relatively low levels of greenhouse gas emissions (natural gas) or none (nuclear)—increase by 2.1 and 2.0 percent per year, respectively, in the Reference case.

Much of the world increase in renewable electricity supply is fueled by hydropower and wind power. Of the 4.5 trillion kilowatthours of increased renewable generation over the projection period, 2.4 trillion kilowatthours (54 percent) is attributed to hydroelectric power and 1.2 trillion kilowatthours (26 percent) to wind. Except for those two sources, most renewable generation technologies are not economically competitive with fossil fuels over the projection period, outside a limited number of niche markets. Typically, government incentives or policies provide the primary support for construction of renewable generation facilities. Although they remain a small part of total renewable generation, renewables other than hydroelectricity and wind—including solar, geothermal, biomass, waste, and tidal/wave/oceanic energy—do increase at a rapid rate over the projection period (Figure 7).

Electricity generation from nuclear power increases from about 2.6 trillion kilowatthours in 2007 to a projected 3.6 trillion kilowatthours in 2020 and then to 4.5 trillion kilowatthours in 2035. Higher future prices for

Figure 7. World renewable electricity generation by energy source, excluding wind and hydropower, 2007-2035 (billion kilowatthours)



fossil fuels make nuclear power economically competitive with generation from coal, natural gas, and liquid fuels, despite the relatively high capital costs of nuclear power plants. Moreover, higher capacity utilization rates have been reported for many existing nuclear facilities, and the projection anticipates that most of the older nuclear power plants in the OECD countries and non-OECD Eurasia will be granted extensions to their operating lives.

Around the world, nuclear generation is attracting new interest as countries seek to increase the diversity of their energy supplies, improve energy security, and provide a low-carbon alternative to fossil fuels. Still, there is considerable uncertainty associated with nuclear power projections. Issues that could slow the expansion of nuclear power in the future include plant safety, radioactive waste disposal, rising construction costs and investment risk, and nuclear material proliferation concerns. Those issues continue to raise public concern in many countries and may hinder the development of new nuclear power reactors. Nevertheless, the *IEO2010* Reference case incorporates improved prospects for world nuclear power. The projection for nuclear electricity generation in 2030 is 9 percent higher than the projection published in last year's *IEO*.

On a regional basis, the Reference case projects the strongest growth in nuclear power for the countries of non-OECD Asia, where nuclear power generation is projected to grow at an average rate of 7.7 percent per year from 2007 to 2035, including projected increases averaging 8.4 percent per year in China and 9.5 percent per year in India. Outside Asia, the largest projected increase in installed nuclear capacity is in Central and South America, with increases in nuclear power generation averaging 4.3 percent per year. Prospects for nuclear generation in OECD Europe have undergone a significant revision from last year's outlook, because a number of countries in the region are reversing policies that require the retirement of nuclear power plants and moratoria on new construction. In the *IEO2010* Reference case, nuclear generation in OECD Europe increases on average by 0.8 percent per year, as compared with the small decline projected in *IEO2009*.

World delivered energy use by sector

Industry

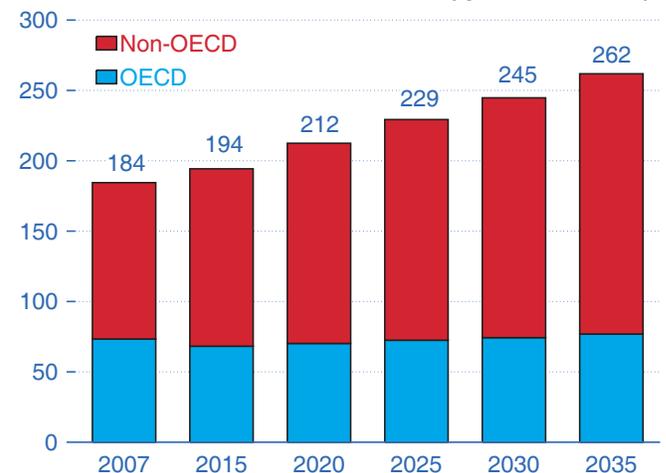
The industrial sector uses more energy globally than any other end-use sector, currently consuming about 50 percent of the world's total delivered energy. Energy is consumed in the industrial sector by a diverse group of industries—including manufacturing, agriculture,

mining, and construction—and for a wide range of activities, such as processing and assembly, space conditioning, and lighting. Worldwide, projected industrial energy consumption grows from 184 quadrillion Btu in 2007 to 262 quadrillion Btu in 2035. The industrial sector accounted for most of the reduction in energy use during the recession, primarily as a result of substantial cutbacks in manufacturing that had more pronounced impacts on total fuel consumption than did the marginal reductions in energy use in other sectors. In the Reference case, national economic growth rates and energy consumption patterns return to historical trends.

Industrial energy demand varies across regions and countries of the world, based on levels and mixes of economic activity and technological development, among other factors. The non-OECD economies account for about 95 percent of the world increase in industrial sector energy consumption in the Reference case. Rapid economic growth is projected for the non-OECD countries, accompanied by rapid growth in their combined total industrial energy consumption, averaging 1.8 percent per year from 2007 to 2035 (Figure 8). Because the OECD nations have been undergoing a transition from manufacturing economies to service economies in recent decades, and have relatively slow projected growth in economic output, industrial energy use in the OECD region as a whole grows by an average of only 0.2 percent per year from 2007 to 2035 (as compared with an average increase of 0.9 percent per year in commercial sector energy use).

A new addition to the energy analysis in *IEO2010* is the incorporation of historical time series and projections for worldwide consumption of marketed industrial renewable energy.⁵ Renewable energy use (excluding

Figure 8. World delivered energy consumption in the industrial sector, 2007-2035 (quadrillion Btu)



⁵It is important to note that marketed (commercial) industrial renewable energy in the United States, including both historical data and projections from the *Annual Energy Outlook*, has always been reported in the *IEO*. The incorporation of data series on industrial sector renewable energy use outside the United States means that all data series are now presented in the *IEO* on a consistent basis worldwide.

consumption of electricity generated from renewable energy sources) constitutes a substantial portion of the world's industrial sector energy consumption. In 2007, the industrial sector consumed 13 quadrillion Btu of non-electricity renewables, or about 7 percent of the sector's total delivered energy use. From 2007 to 2035, renewable energy use in the industrial sector worldwide increases by an average of 1.8 percent per year, and the renewable share of total delivered energy use in the industrial sector increases to 8 percent in 2035. Biomass for heat and power production currently provides the vast majority of renewable energy consumed in the industrial sector (90 percent), and it is expected to remain the largest component of the industrial sector's renewable energy mix through the projection period.

Transportation

Energy use in the transportation sector includes the energy consumed in moving people and goods by road, rail, air, water, and pipeline. The transportation sector is second only to the industrial sector in terms of total end-use energy consumption. Almost 30 percent of the world's total delivered energy is used for transportation, most of it in the form of liquid fuels. The transportation share of world total liquids consumption increases from 53 percent in 2007 to 61 percent in 2035 in the *IEO2010* Reference case, accounting for 87 percent of the total increase in world liquids consumption. Thus, understanding the development of transportation energy use is the most important factor in assessing future trends in demand for liquid fuels.

World oil prices reached historically high levels in 2008, in part because of a strong increase in demand for transportation fuels, particularly in emerging non-OECD economies (Figure 9). Non-OECD energy use for transportation increased by 4.5 percent in 2007 and 7.3 percent in 2008, before the impact of the 2007-2009 global

economic recession resulted in a slowdown in transportation sector activity. Even in 2009, non-OECD transportation energy use grew by an estimated 3.2 percent, in part because many of the non-OECD countries (in particular, but not limited to, the oil-rich nations) provide fuel subsidies to their citizens. With robust economic recovery expected to continue in China, India, and other non-OECD nations, growing demand for raw materials, manufactured goods, and business and personal travel is projected to support fast-paced growth in energy use for transportation both in the short term and over the long term. In the *IEO2010* Reference case, non-OECD transportation energy use grows by 2.6 percent per year from 2007 to 2035.

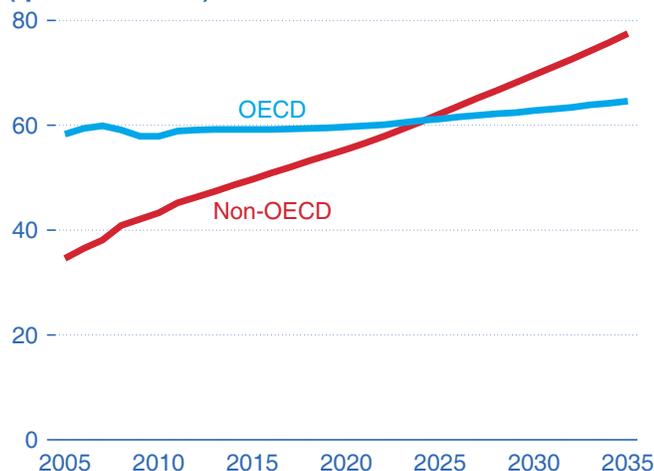
In comparison with the non-OECD economies, high oil prices and economic recession had more profound impacts on the OECD economies. OECD energy use for transportation declined by an estimated 1.3 percent in 2008, followed by a further decrease estimated at 2.0 percent in 2009. Indications are that a return to growth in transportation energy use in the OECD nations will not begin before late 2010, given the relatively slow recovery from the global recession anticipated for many of the key OECD nations. Moreover, the United States and some of the other OECD countries have instituted a number of new policy measures to increase the fuel efficiency of their vehicle fleets, as well as fuel taxation regimes to encourage fuel conservation. Thus, OECD transportation energy use, growing by only 0.3 percent per year over the entire projection period, does not return to its 2007 level until after 2020.

In the long term, for both the non-OECD and OECD economies, steadily increasing demand for personal travel is a primary factor underlying projected increases in energy demand for transportation. Increases in urbanization and in personal incomes have contributed to increases in air travel and motorization (more vehicles per capita) in the growing economies. Increases in the transport of goods are expected to result from continued economic growth in both OECD and non-OECD economies. For freight transportation, trucking is expected to lead the growth in demand for transportation fuels. In addition, as trade among countries increases, the volume of freight transported by air and marine vessels is expected to increase rapidly.

Residential and commercial buildings

The buildings sector—comprising residential and commercial consumers—accounts for about one-fifth of the world's total delivered energy consumption. In the residential sector, energy use is defined as the energy consumed by households, excluding transportation uses. The type and amount of energy used by households vary from country to country, depending on income levels, natural resources, climate, and available energy

Figure 9. World delivered energy consumption in the transportation sector, 2005-2035 (quadrillion Btu)



infrastructure. Typical households in OECD nations use more energy than those in non-OECD nations, in part because higher income levels in the OECD nations support purchases of larger homes and more energy-using equipment.

For residential buildings, the physical size of a structure is one key indicator of the amount of energy used by its occupants, although income level and a number of other factors, such as weather, also can affect the amount of energy consumed per household. Controlling for those factors, larger homes generally require more energy to provide heating, air conditioning, and lighting, and they tend to include more energy-using appliances, such as televisions and laundry equipment. Smaller structures usually require less energy, because they contain less space to be heated or cooled, produce less heat transfer with the outdoor environment, and typically have fewer occupants.

In the *IEO2010* Reference case, world residential energy use increases by 1.1 percent per year over the projection period, from 50 quadrillion Btu in 2007 to 69 quadrillion Btu in 2035. Much of the growth in residential energy consumption occurs in the non-OECD nations, where robust economic growth improves standards of living and fuels demand for residential energy. Non-OECD residential energy consumption rises by 1.9 percent per year, compared with the much slower rate of 0.4 percent per year for the OECD countries, where patterns of residential energy use already are well established, and slower population growth and aging populations translate to smaller increases in energy demand.

The commercial sector—often referred to as the services sector or the services and institutional sector—consists of businesses, institutions, and organizations that provide services. The sector encompasses many different types of buildings and a wide range of activities and energy-related services. Examples of commercial facilities include schools, stores, correctional institutions, restaurants, hotels, hospitals, museums, office buildings, banks, and sports arenas. Most commercial energy use occurs in buildings or structures, supplying services such as space heating, water heating, lighting, cooking, and cooling. Energy consumed for services not associated with buildings, such as for traffic lights and city water and sewer services, is also categorized as commercial energy use. Economic trends and population growth drive activity in the commercial sector and the resulting energy use.

The need for services (health, education, financial, and government) increases as populations grow. The degree to which additional needs are met depends in large measure on economic resources—whether from domestic or foreign sources—and economic growth. Economic growth also determines the degree to which additional

activities are offered and used in the commercial sector. Higher levels of economic activity and disposable income lead to increased demand for hotels and restaurants to meet business and leisure requirements; for office and retail space to house and service new and expanding businesses; and for cultural and leisure space, such as theaters, galleries, and arenas.

OECD commercial energy use expands by 0.9 percent per year in the *IEO2010* Reference case. Slow expansion of GDP and low or declining population growth in many OECD nations contribute to slower anticipated rates of increase in commercial energy demand. In addition, continued efficiency improvements moderate the growth of energy demand over time, as energy-using equipment is replaced with newer, more efficient stock. Conversely, continued economic growth is expected to include growth in business activity, with its associated energy use, in areas such as retail and wholesale trade and business, financial services, and leisure services.

In non-OECD nations, economic activity and commerce increase rapidly over the 2007-2035 projection period, fueling additional demand for energy in the service sectors. Population growth also is expected to be more rapid than in the OECD countries, portending increases in the need for education, health care, and social services and the energy required to provide them. In addition, as developing nations mature, they are expected to transition to more service-related enterprises, which will increase demand for energy in the commercial sector. The energy needed to fuel growth in commercial buildings will be substantial, with total delivered commercial energy use among the non-OECD nations projected to grow by 2.7 percent per year from 2007 to 2035.

World Carbon Dioxide Emissions

World energy-related carbon dioxide emissions rise from 29.7 billion metric tons in 2007 to 33.8 billion metric tons in 2020 and 42.4 billion metric tons in 2035—an increase of 43 percent over the projection period. With strong economic growth and continued heavy reliance on fossil fuels expected for most of the non-OECD economies under current policies, much of the projected increase in carbon dioxide emissions occurs among the developing non-OECD nations. In 2007, non-OECD emissions exceeded OECD emissions by 17 percent; in 2035, they are projected to be double the OECD emissions (Figure 10).

A significant degree of uncertainty surrounds any long-term projection of energy-related carbon dioxide emissions. Major sources of uncertainty include estimates of energy consumption in total and by fuel source. The Kaya Identity provides an intuitive approach to the interpretation of historical trends and future projections of carbon dioxide emissions. It is a mathematical

expression that is used to describe the relationship among the factors that influence trends in emissions: carbon intensity of energy (the amount of energy-related carbon dioxide emissions emitted per unit of energy produced), energy intensity of the economy (energy consumed per dollar of GDP), output per capita (GDP per person), and population.

Of the four Kaya components, policymakers are most actively concerned with the energy intensity of the

economy and carbon intensity of energy, which are more readily affected by the policy levers available to them for reducing greenhouse gas emissions. In the *IEO-2010 Reference case*, assuming no new climate policies, worldwide increases in output per capita and relatively moderate population growth overwhelm projected improvements in energy intensity and carbon intensity (Figure 11).

Figure 10. World energy-related carbon dioxide emissions, 2007-2035 (billion metric tons)

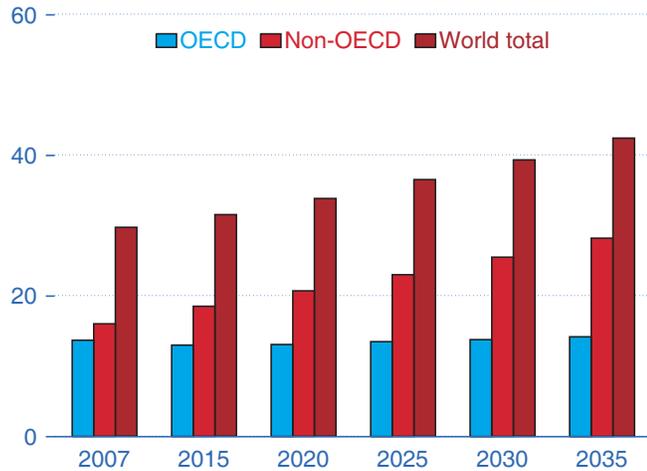


Figure 11. Impacts of four Kaya factors on world carbon dioxide emissions, 1990-2035 (index: 2007 = 1.0)

